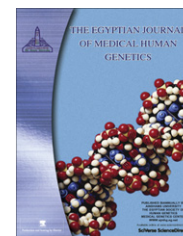




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ORIGINAL ARTICLE

Consanguineous matings among Egyptian population

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Abstract Consanguinity is the blood relationship that exists among individuals that descend from a common ancestor. The objectives of the study was to explore the frequency and socio-economic determinants of consanguinity in Egypt. The study was carried out using a cross-sectional approach which included 10,000 unselected couples. All couples were recruited from the prenatal, gynecologic, neonatal and pediatric clinics as well as vaccination centers in three hospitals one in Lower Egypt (Cairo) and two in Upper Egypt (Sohag and Assuit).

Consanguineous marriage is still high in Egypt (35.3%), especially among first cousins (86%). However the frequency varies by region. It is higher in Sohag (42.2%) and Cairo (36.1%) than in Assuit (21.7%). Also it was higher in rural areas (59.9%) than in semi-urban and urban areas (23.5% and 17.7%, respectively). It was associated with decreased age of marriage, low educational level and unemployment in the couples which means that the socio-economic determinants are still working in maintaining this high rate of consanguinity. This is in addition to the high divorce rate and increased number of unmarried females in Egypt.

Advances in genetics have led to a deeper understanding of the effect of inbreeding on the occurrence of genetic diseases. As prolonged parental inbreeding has led to a background of homozygosity above that predicted by simple models of consanguinity, we encourage counselors to call on a reliable computer program for calculation of the recurrence risks in these families.

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1. Introduction

Consanguinity means marriage between two persons descended from the same ancestor and in practice, this ancestor is usually taken to be no more remote than a great-great grand parent. The genetic definition indicates unions contracted between persons biologically related as 2nd cousins or closer ($F \geq 0.0156$). Globally, the most common form of consanguineous union contracted is between first cousins, in which the spouse share 1/8 of their genes inherited from a common ancestor and so

their progeny are homozygous at 1/16 of all loci. This is expressed as the co-efficient of inbreeding (F) and for first cousin offspring, $F = 0.0625$. That is the progeny are predicted to have inherited gene copies from each parent at 6.25% of all gene loci, over and above base line level of homozygosity in the general population. In some large human populations genetically closer marriages also are favored, in particular uncle-niece and double first cousin unions where the level of homozygosity in the progeny is equivalent to 0.125 [1].

Although the frequency of consanguineous marriage is generally declining, most Middle Eastern Arabs still have a custom of preferring consanguineous marriage particularly among first cousins [2]. The rate of consanguineous marriage varies in different countries and is usually associated with some demographic features, as religion, educational level, socio-economic status, location and size of the area, isolation of population, consanguinity in parents' marriages, responders' attitude towards consanguineous marriage, and living in rural or urban area [3].

Some individuals choose to marry partner not only from the same geographical area, but also with similar physical characteristics, religious beliefs, educational backgrounds and even political opinions [1]. It is believed that consanguineous marriages would preserve family structure and provide social, economic and cultural benefits although the Islamic religion discourages it [4].

Previous studies have pointed out the adverse health effects of consanguineous marriage; it has a greater risk not only of producing offspring which are homozygous for a deleterious recessive gene, but also individuals with increased susceptibility for polygenic or multifactorial disease, sterility, still births, spontaneous abortions, child death, infant mortality, as well as congenital malformations [5].

1.1. Demographic features of Egypt

Egypt is located at the juncture of the ancient world continents of Africa, Asia and Europe. It is divided into Upper Egypt, Lower Egypt, Suez Canal and Northern Coast lakes regions. Egypt is also divided into 26 governorates; four mainly urban and the other 22 have urban, semi-urban and rural areas. Nine of the mixed governorates are in Lower Egypt and eight in Upper Egypt, while the remaining five are the eastern and western boundaries of Egypt [6].

Egyptian population hit 72.5 millions. The number of males reached 37.2 millions and females 35.4 millions. Population in urban areas is about 30.95 millions and in rural areas is about 41.63 millions. Ninety-eight percent of the populations are descended from Ancient Egyptian Society. Ethnic minorities include Berbers, Nubians, Bedouin Arabs, Beja and Dome and constitute 1%. Greek, Armenians and other Europeans constitute 1% [6].

Average family size is falling from 4.65 people in 1996 to 4.16 in 2006. However family size is still high and fertility rates are especially high in rural areas [6].

2. Aim of the study

The study aims to detect the frequency and pattern of consanguineous matings among a sample of Egyptian population residing in three governorates; one in Lower Egypt (Cairo) and two in Upper Egypt (Assuit and Sohag). Also to identify

socio-economic and demographic variables associated with consanguineous marriage.

3. Subjects and methods

3.1. Choice of sample

The study was carried out using a cross-sectional approach of 10,000 unselected couples taken from three governorates in Egypt to reflect properly the prevalence of consanguinity. The sample included 4377 (43.8%) families from Sohag and 2292 (22.9%) from Assuit (Upper Egypt), as well as 3331 (33.3%) from Great Cairo (Lower Egypt). Assuit and Sohag have urban, semi-urban as well as rural populations, while Cairo is mainly urban and semi-urban. Families were chosen from prenatal, gynecologic, neonatal and pediatrics clinics as well as from vaccination centers. Families attending genetics clinics were excluded.

3.2. A questionnaire was given to all the families which included the following:

1. Are parents related, if yes, what is the exact relation. The answer will be written in Arabic as told by the interviewed person.
2. The year of marriage will be recorded.
3. Age of mother and father at time of marriage, their education (illiterate or educated and degree of education), parity, their religion, working or not and type of work.

3.3. Parental consanguinity was classified into [7]:

- First cousins who share the same grand parents.
- First cousins once removed, who descend from a common ancestor but differ in the number of generations.
- Second-cousins.
- Double first cousins (all grand parents are shared).

3.4. Statistical analysis

Qualitative data will be presented as frequencies and percentages. Chi-square (χ^2) test was used for studying the comparisons between different qualitative variables. Quantitative data were presented as minimum, maximum, means and standard deviation (SD) values. Student's t -test was used for comparisons between means of two groups. The significance level was set as $P \leq 0.05$. Statistical analysis was performed with SPSS 16.0 (Statistical Package for Scientific Studies) for windows.

Calculation of coefficient of inbreeding (F): the average coefficient of inbreeding $\alpha = \sum p_i F_i$, where p_i is the relative frequency of consanguineous marriages with a coefficient of parental relationship F_i . Calculations were for whole period of the study [8].

4. Results

1. The frequency of consanguineous matings in the Egyptian population in general and in the urban, semi-urban and rural areas as well as its degree, the relation of consanguinity with religion, age of parents at marriage, year of marriage, and degree of education as well as the type of work of parents are presented in Table 1.

Table 1 Prevalence of consanguineous matings in the Egyptian population and associated demographic and socioeconomic determinants.

	Non-consanguineous 6470, No. (%)	Consanguineous 3530, No. (%)	χ^2 value	P-value
Governorate				
Total	6470 (64.7)	3530 (35.3)	19.565	< 0.001*
Sohag	2056 (44.7)	1488 (42.2)		
Cairo	2889 (31.8)	1275 (36.1)		
Assuit	1525 (23.6)	767 (21.7)		
Residence				
Rural	2910 (45.0)	2113 (59.9)	254.755	< 0.001*
Semi-urban	1654 (25.6)	829 (23.5)		
Urban	1906 (29.5)	588 (16.7)		
Degree				
1st cousins		1837 (86.0)		
1st cousins once removed		222 (6.3)		
Double 1st cousins		80 (2.3)		
2nd cousins		191 (5.4)		
Religion				
Muslim	5068 (78.3)	2781 (78.8)	0.275	0.600
Christians	1402 (21.7)	749 (21.2)		
Age of marriage (Y)				
Females				
15–25	2526 (39.0)	2495 (70.7)	921.439	< 0.001*
26–35	2839 (43.9)	694 (19.7)		
36–45	1105 (17.1)	341 (9.7)		
Males				
15–25	2745 (42.4)	2156 (61.1)	318.645	< 0.001*
26–35	2152 (33.3)	814 (23.1)		
36–45	1573 (24.3)	560 (15.9)		
Year of marriage				
1960–1970	2 (0.03)	0 (0)	3.782	0.436
1971–1980	991 (15.3)	505 (14.3)		
1981–1990	1802 (27.9)	12020 (28.9)		
1991–2000	2078 (32.1)	1119 (31.7)		
2001–2007	1591 (24.6)	881 (25.0)		
Education				
Females				
Not educated	4103 (63.4)	23.38 (66.2)	32.377	< 0.001*
1ry educated	840 (13.0)	474 (13.4)		
Preparatory schools	348 (5.4)	192 (5.4)		
Secondary schools	787 (12.2)	377 (10.7)		
High education	392 (6.0)	149 (4.3)		
Males				
Not educated	3704 (57.2)	2114 (59.9)	19.242	< 0.002*
1ry educated	873 (13.5)	506 (14.3)		
Preparatory schools	558 (8.6)	280 (7.9)		
Secondary schools	828 (12.8)	422 (12.0)		
High education	507 (7.8)	208 (5.9)		
Parents job				
Females				
Not working	5917 (91.5)	3301 (93.5)	15.140	0.002*
Simple worker	141 (2.2)	59 (1.7)		
Experienced technicians	125 (1.9)	42 (1.2)		
Employee	287 (4.4)	128 (3.6)		
Males				
Not working	2137 (33.0)	1161 (32.9)	24.808	< 0.001*
Simple worker	1662 (25.7)	1051 (29.8)		
Technicians	417 (6.4)	222 (6.3)		
Experienced technicians	1656 (25.6)	822 (23.3)		
Employee	598 (9.2)	274 (7.8)		

Y = years. < 0.05 = significant.

Table 2 Prevalence of consanguinity in this study as well as in previous Egyptian studies.

Location	Collection period	Average frequency (%)	First cousin (%)	<i>F</i>	Reference
Cairo	1959	39 (U)			[9]
Cairo	1967	34.49 (U)	61.08	0.0161	[10]
Cairo	1969	32 (U)			[11]
All Egypt	1970	28.96	14.10	0.010	[12]
	Early 1980	39.11 (R)		0.0147	
		26.79 (SU)		0.0105	
		22.05 (U)		0.0092	
All Egypt	1987	26.2 (R)			[13]
		20.37 (U)			
Assuit (LE)	1991–1993	36.9			[14]
		55.2 (R)			
		25.4 (U)			
Alexandria (LE)	1994	22.8 (U)	15.8	0.01172	[15]
Alexandria (LE)	2000	20.9 (U)	15.9		[16]
All Egypt	2004	39.9	22.2		[17]
		55.2 (R)			
		25.4 (U)			
All Egypt	2005	32.2	17.5 (1C)	0.0109	[18]
		24 (U)	7.3 (2C)	0.0011	
		37.9 (R)	Others 7.4		
All Egypt	2007	33.1			[19]
All Egypt	2008	29.7	15.6	0.0061	[20]
		23.2 (U)			
		34.3 (R)			
Giza (LE)	2008	32	57.24		[21]
Dakahlia	2009/2010	19.8			
Mansoura (LE)		20 (U)	7.9	0.0049	[22]
		17.14 (R)			
All Egypt	2010	35.3	8.6 (1C)		
Cairo (LE)		36.1			
Sohag (UE)		42.2	5.4 (2C)	0.019	Present study
Assuit (UE)		21.7			
		45 (R)			
		25.6 (SU)			
		29.5 (U)			

LE: Lower Egypt; UE: Upper Egypt; 1C: first cousin; 2C: second cousins; R: rural; SU: semi-urban; U: urban; *F*: coefficient of inbreeding.

2. Frequency of consanguinity in previous Egyptian studies is presented in Table 2.

5. Discussion

5.1. Prevalence of consanguinity

This study showed that the overall frequency of consanguinity in Egypt is still high (35.3%), however this frequency varies by region. It was significantly higher in Sohag (42.2%) and great Cairo (36.1%) than in Assuit (21.7%). It is to be noted that the frequency of consanguinity did not significantly differ between different years of marriage, although it was noticed that it is increasing through the years, till year 2000. In previous Egyptian studies it ranged from 22.9% to 39.9% depending on the region [9–22]. It is well known that the practice of consanguineous marriage in Egypt is very old since Ancient Egyptians to keep the royal blood [23]. In contrast to the recent decline in the prevalence of consanguineous marriage that was reported in Middle Eastern countries such as Jordan and Saudi Arabia, an increases have been reported in other Arab countries as

Qatar and United Arab Emirates which still have a custom of preferring consanguineous marriages [3,4].

In previous Egyptian studies as well as this one, first cousin marriages occurred more often than other types of consanguinity (86%). The same was also reported in other Arab countries [24–26], in Tehran [27], in Bengal and India [28] and in Spain [29]. On the other hand, a high frequency of unions among second cousins was reported in the Parrish of Dota and Costa Rica populations [30]. Among Arabs it constitutes 20–52% of all marriages [1,3,4] and first cousin marriages constitute almost one third of all marriages [2,31,32].

5.2. Aetiology of consanguinity

It has been a long standing social habit among Egyptians. The etiology of this high degree of consanguinity is nearly the same in all Arab countries. It includes maintenance of family structure, stability, durability as well as keeping property. It has financial advantages relating to dowry or bride wealth payment and ease of marital arrangements. It will also strengthen family ties and build closer relationship between the wife and her in-laws [33,34]. This means that it has

significant social and economic advantages. We also noticed that consanguinity between the parents increases the chance of consanguineous marriage among their children.

One unique etiology among Egyptians is the high divorce rate which increased to 30.1% among youth aged between 18 and 29 years in Egypt [6]. This means that many marriages are getting more fragile and many families believe that there may be more compatibility and fewer tendencies to divorce between husband and wife from same family.

Another cause reported in Egypt is the increased number of unmarried females. From year 2006, the percentage of unmarried women in 30–39 age brackets was 5.2% up from 3.9% in 1996 [35]. The factors that impede marriage in one study were mainly due to associated expenses, cited by 61% of males and 59% of females. The hassle of finding an apartment came second, according to 52% of males and 46% of females. Finding a Job placed third, as cited by 20% males and 40% of females. Only 4% of females attributed the delay in marriage to the fact that they have not found the suitable partner [35]. That is why many girls prefer to marry a relative instead of waiting another unrelated husband to decrease the expenses of marriage. Despite these various advantages, problems arising from marriage to a close relative have been cited in a minority of cases [1,35,36] especially where there is a large age gap between spouses.

5.3. Consanguinity and religion

Muslims constitutes about 90% of the Egyptian population, Coptic 9% and other Christians constitute 1%. In our study consanguinity was more common among Muslims than among Christians, but with no significant difference ($P < 0.05$). The same was also reported in Lebanon [37] and other Arab countries where consanguineous marriage is mostly due to cultural and economic reasons and not related to religion [28]. However in other studies [25,38] consanguinity was higher among Muslims than other religions. Attitudes towards consanguinity within Islam are somewhat ambiguous. While the prevalence of close-kin, marriage exceeds 50% in many Muslim countries of the Middle East and Pakistan, there is no specific guidance in the Quran that could be interpreted as encouraging consanguinity [7]. Indeed according to one of the Hadith, recorded pronouncements of the Prophet Mohammad cousin marriages was best discouraged. However it can be interpreted as following the Sunnah, i.e., the deeds of the prophet [7].

5.4. Consanguinity and degree of urbanization

In this study, consanguinity is more prevalent in rural than in semi-urban or urban populations. This was also reported by previous studies in Egypt as well as in other countries [21,24,39,40]. Such results could have been expected since the rural society is somewhat isolated and the family relations are stronger than in urban areas [12]. Also unquestioning obedience to parents by their children irrespective of their age is still practiced in these areas. Rural areas are also typified by low levels of maternal education, early age of marriage, short birth intervals and longer reproductive spans. Each of these factors is independently associated with larger family sizes and higher rates of infant and early childhood mortality, with reproduction compensation for early losses, a further complicating issue in assessing the overall health outcomes of consanguinity [41].

5.5. Consanguinity and age of marriage

Age groups between 15 and 45 years in Egypt constituted about 48.2% and the average age of marriage for women was 20.6 years (22.4 years in urban areas and 19.4 years in rural areas) while the average marriage age for men was 29 [35]. In our study, consanguinity was significantly increased in the age range of 15–25 years, in both males and females than in the older age groups ($P < 0.05$ and < 0.001). The same was also previously reported in Alexandria Egypt by Sallam et al. [42]. He reported that the causes of early marriage include consanguinity, illiteracy and unawareness of reproductive health. The same was also reported in other areas of Egypt [15] as well as in other Arab countries [43]. On the other hand Gruz et al. stated that the frequency of consanguinity did not vary in different age groups [39].

5.6. Consanguinity and educational level of the parents

It is to be noted that in Egypt 27% of young people in the age group between 18 and 29 years-old have not completed their basic education, as 17% dropped out of school before completing their primary education and 10% did not attend school at all [6]. Also the obstacle facing females is getting an education especially in remote rural areas.

In our study, consanguinity showed significantly higher levels among non-educated mothers (66.2%) and fathers (59.9%). The lowest prevalence of consanguinity was found among high educated parents. Also it is noticed that more than half of studied families were non-educated (53.3%). This supports the findings of other authors who found that low education subgroups have the highest rates of consanguinity and higher education unions had the lowest rates of consanguinity [25,36,38,39,43,44].

5.7. Consanguinity and parents Jobs

In our study, the prevalence of consanguinity among non-working mothers was significantly higher than among working mothers ($P < 0.05$). Also it is significantly higher among non-working and simple worker fathers than among technicians, and employees ($P < 0.001$). This is in agreement with other studies who demonstrated that women working only in home presented the highest rates of consanguinity [25].

5.8. Consanguineous marriage and their health impact

Many epidemiologic studies have examined consanguineous marriages and their health impact on the offspring. Primarily offspring of consanguineous parents are at two-fold greater risk than the offspring of non related parents for autosomal recessive disorders. Advances in genetics have led to a deeper understanding of the impact of inbreeding on the occurrence of genetic anomalies. Studies showed that inbreeding is associated with mortality and morbidity in fetal, neonatal and childhood stages. There is also a relationship between consanguinity and birth measurements, specific physical defects and behavioral and psychiatric disorders [7,8]. Because consanguinity represents a risk factor for the occurrence of many deleterious outcomes, it is of major scientific and public health interest.

Individuals born of consanguineous unions have segments of their genomes that are homozygous as a result of inheriting

identical ancestral genomic segments through both parents. One consequence of this is increased incidence of recessive disease within this sib ships. Theoretical calculations predict that 6% (1/16) of the genome of a child of first cousins will be homozygous and that the average homozygous segment will be 20 cm in size [45]. Woods et al. [46] also found that individuals with a recessive disease whose parents were first cousins, on average 11% of their genome were homozygous, with each individual bearing 20 homozygous segments exceeding 3 cm and that the size of homozygous segments associated with recessive disease was 26 cm. These data imply that prolonged parental inbreeding has led to a background level of homozygosity increased ~5% over and above that predicted by simple models of consanguinity. The coefficient of inbreeding (F) gives the probability that a locus will be identical by descent in an individual (and the proportion of the autosomal genome that will be homozygous). However in clinical practice this can rarely be calculated with confidence, because of incomplete knowledge of a sufficient ancestry [46]. By analyzing 10,000 SNPs spread throughout the genome, inbreeding coefficient for an individual can be better calculated than by inferential methods [47]. Also counselors are encouraged to call on a reliable computer program for any but the simplest cases so that actual risk calculations are done [48].

6. Conclusion

Consanguineous marriage has long been a controversial topic. It is still prevalent in Egypt especially in rural areas where marriage of non-educated and unemployed persons are practiced. High population growth in Egypt (1.3 million people/year) was the cause of the whole array of economic and social problems [6]. We are in need to improve the socio-economic and educational status. There is also need to increase public awareness of reproductive health and anticipated deleterious effects of inbreeding.

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